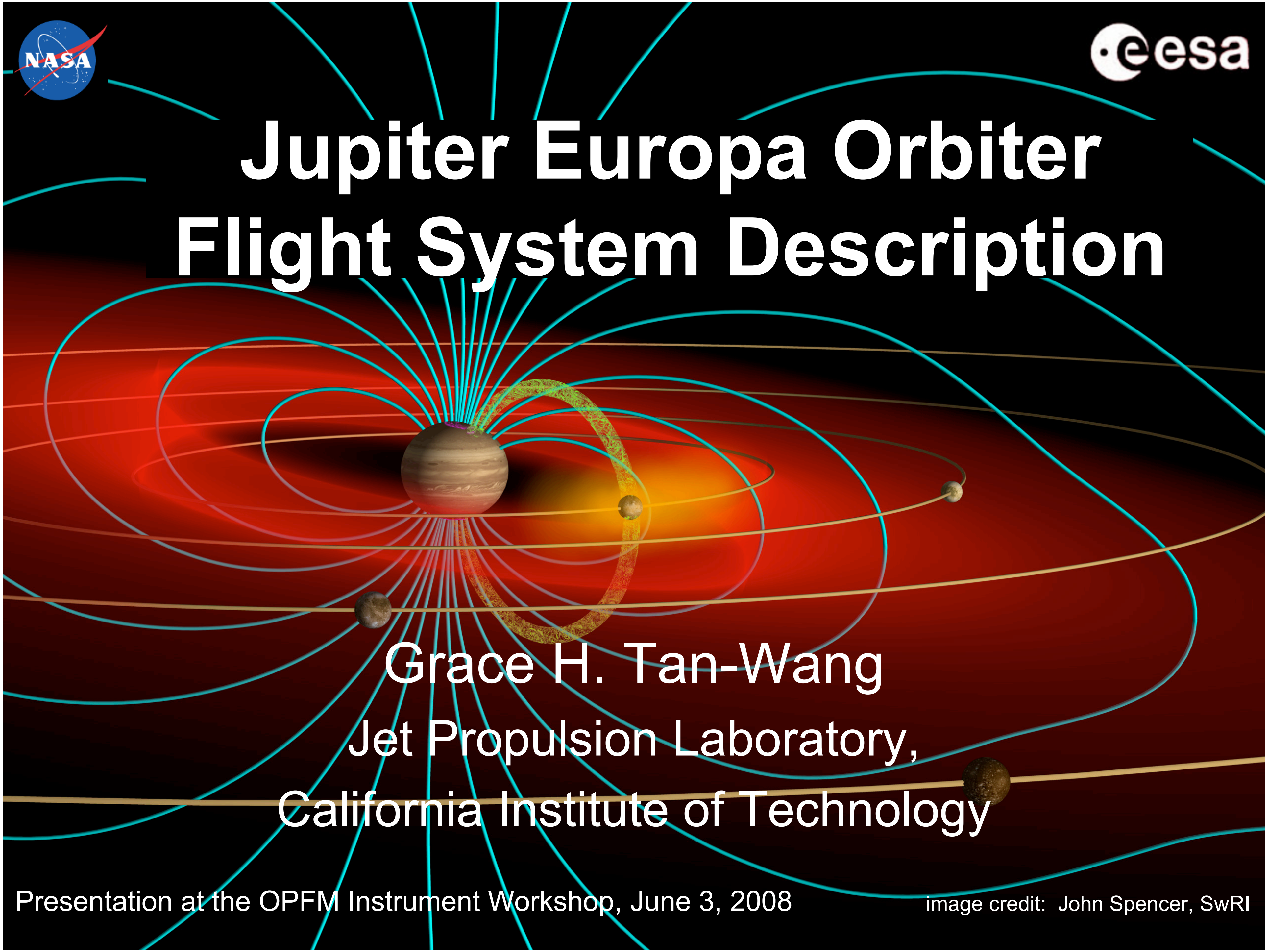
Jupiter Europa Orbiter Flight System Description



Grace H. Tan-Wang

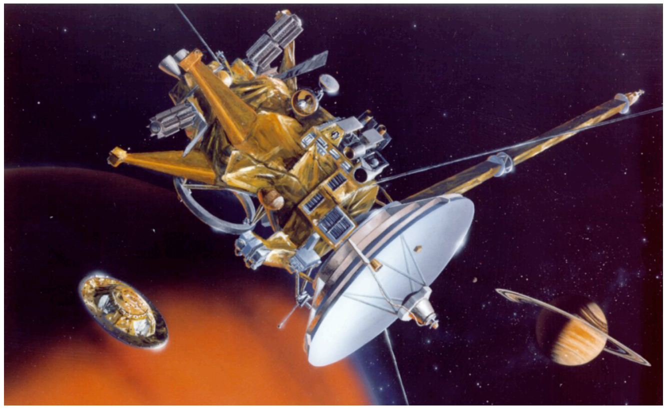
Jet Propulsion Laboratory,

California Institute of Technology

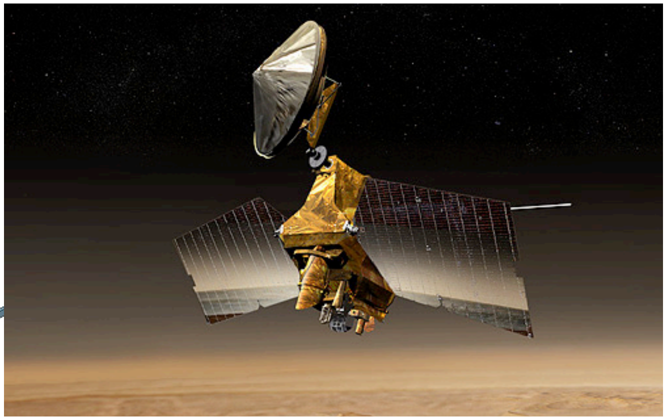
Presentation at the OPFM Instrument Workshop, June 3, 2008

image credit: John Spencer, SwRI

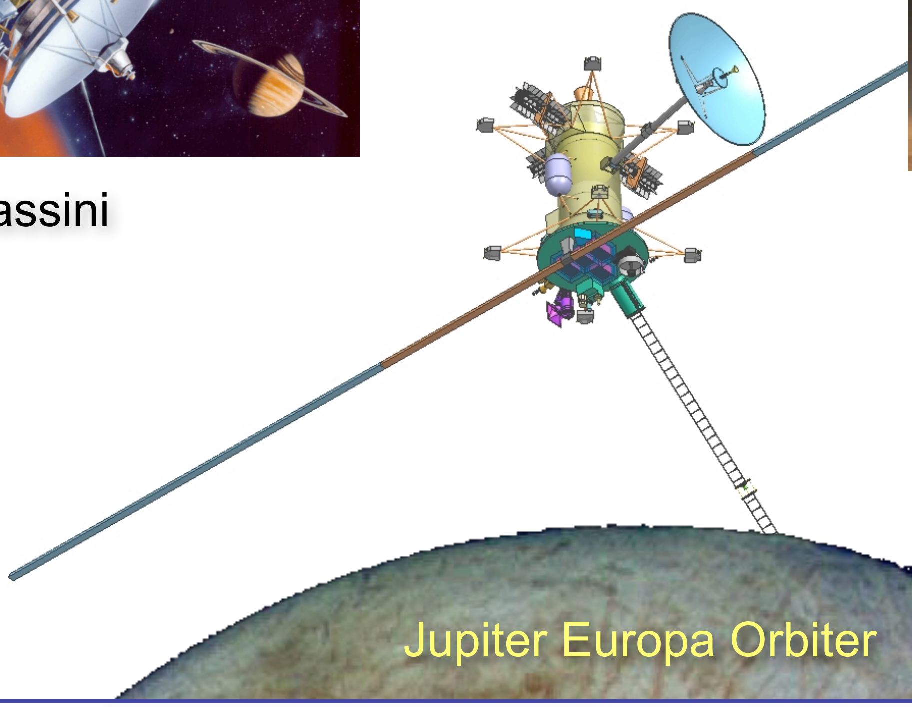
JEO – A Deep Space Orbiter Mission



Cassini

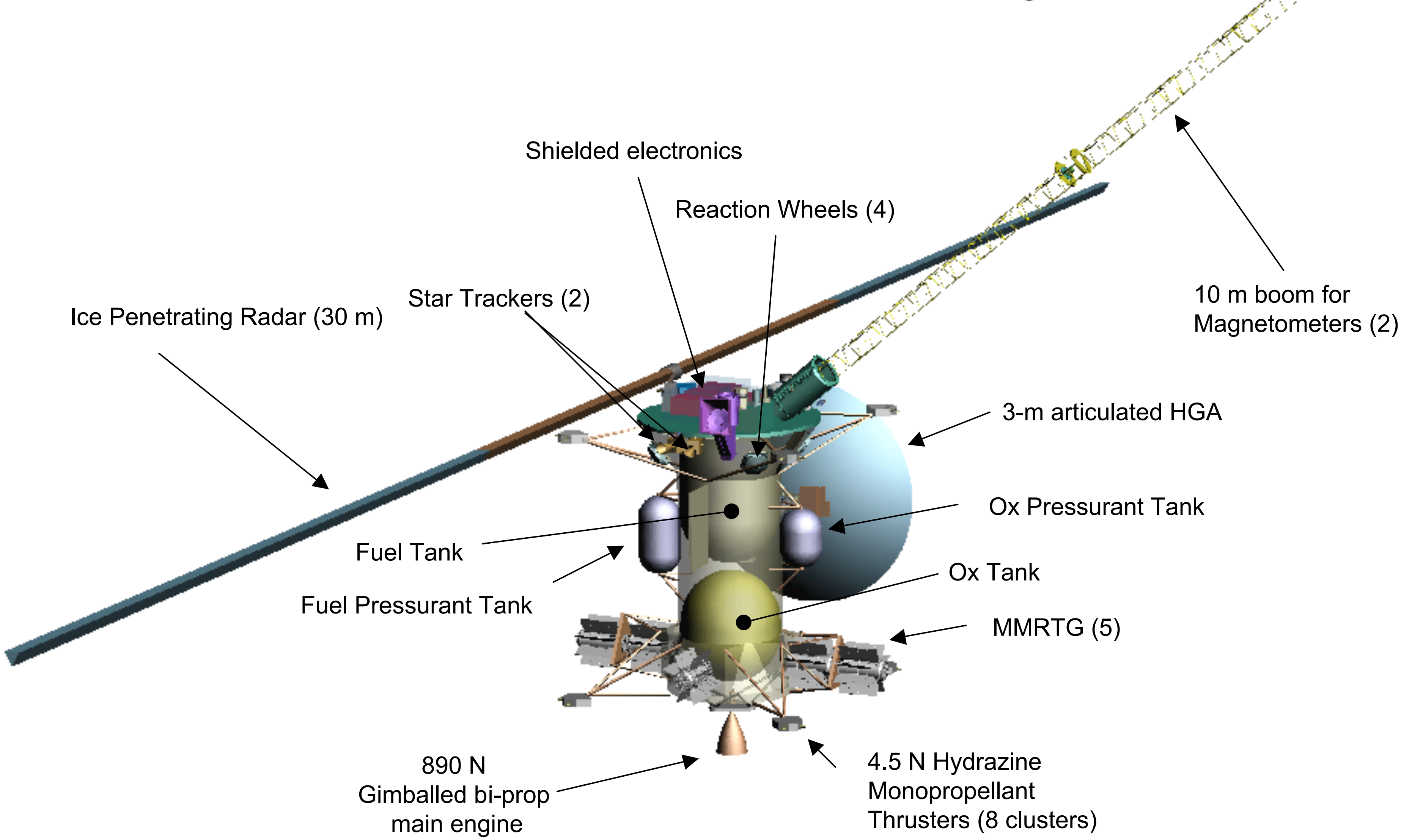


MRO

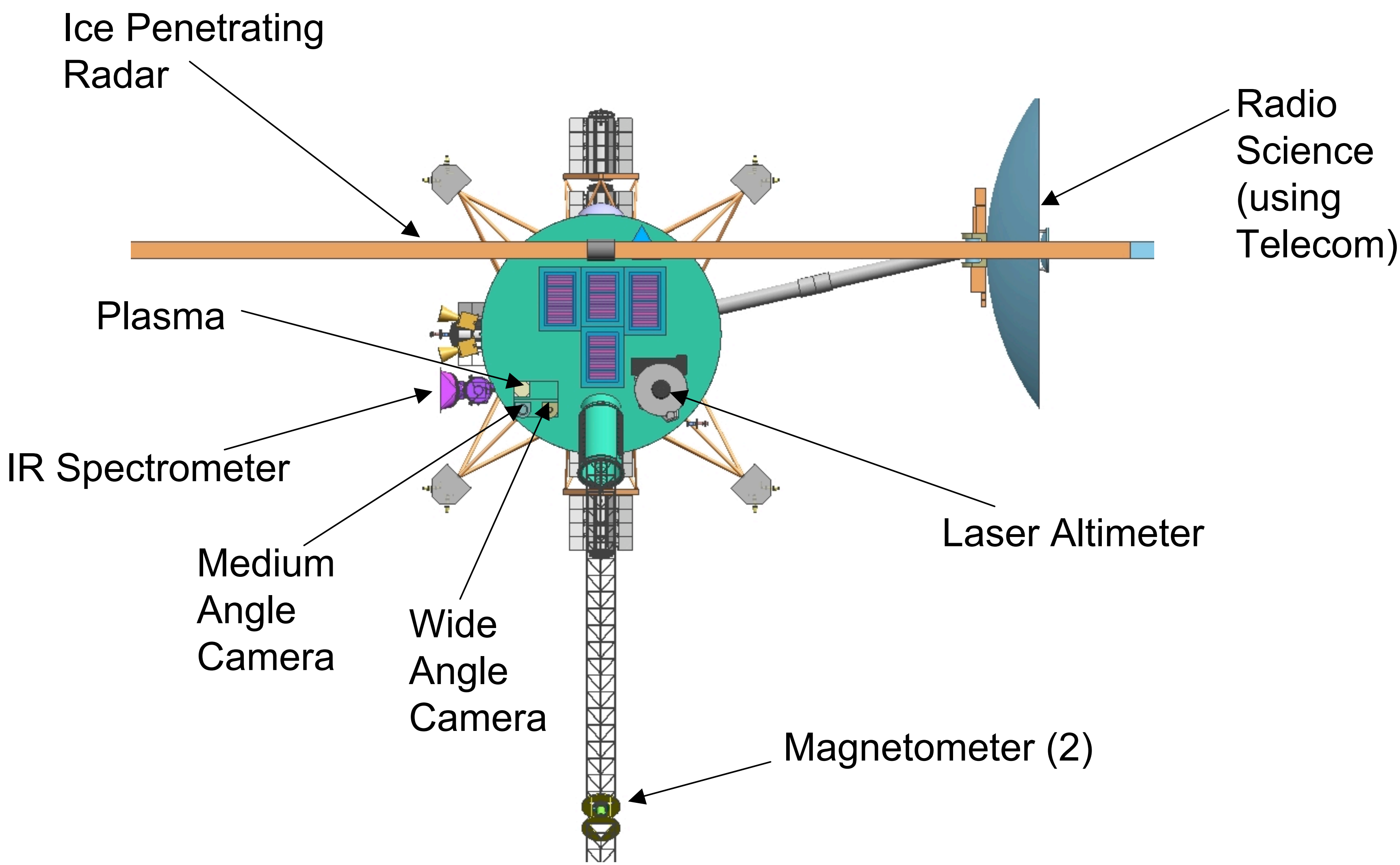


Jupiter Europa Orbiter would be a deep space orbiter mission with similar functions and design parameters as other JPL orbiter missions.

JEO Baseline Spacecraft Configuration



JEO Baseline Payload Configuration



Notional JEO Planning Payload*

Payload Instruments	Inc?	Mass (kg)	Power (W)	Change From EE07 Floor
Team 1: Ocean				
Radio Science	Y			Ka + X-bands
Laser Altimeter (LA)	Y	7	15	Single beam
Team 2: Ice				
Ice Penetrating Radar (IPR)	Y	31	45	Dipole only
Team 3: Chemistry				
Near-IR Spectrometer (IRS)	Y	20	20	Higher estimated mass
Team 4: Geology				
Wide- + Med-Angle Camera (WAC+MAC)	Y	10	12	MAC has color filters
Team 5: MAPS				
Dual Magnetometer	Y	4	2	Dual MAG on 10 m boom
Plasma Instrument	Y	7	10	Based on PEPE
TOTALS:		79	104	
2007 Floor TOTALS:		77	106	

Does not reflect latest planning payload from SDT last week (5/30/08)

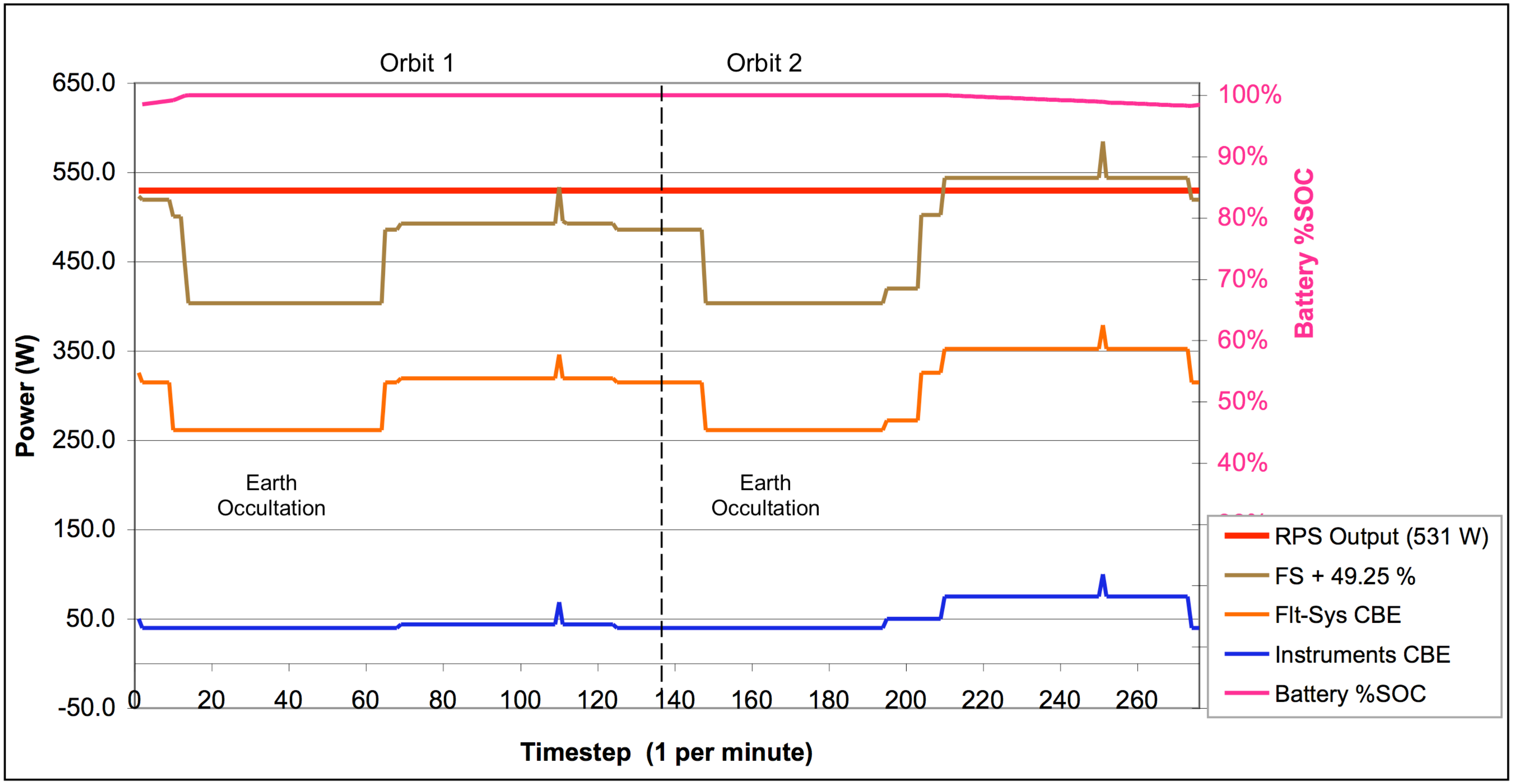
* Notional set of instruments that could meet science measurement requirements for understanding engineering needs; Actual instrument selections to be done via NASA AO process

Current JEO Mass Estimates

Europa Mass Equipment List			
	Flight System Mass, kg		
	CBE	Cont.	CBE + Cont.
Payload	73	30%	95
Instrument Planning Payload	73.3	30%	95.3
Bus	1213	25%	1516
ACS	67.7	33%	90.0
CDH	29.7	17%	34.7
Power (w/o RPSs)	55.0	30%	71.6
RPS System	226.0	0%	226.0
Propulsion	142.2	27%	181.0
Structures & Mechanisms	353.1	31%	463.4
Cabling	75.2	44%	108.3
Telecom	51.5	26%	65.1
Radiation Monitoring System	8.0	30%	10.4
Thermal	65.5	30%	85.1
Radiation Shielding	138.9	30%	180.6
Spacecraft Total Dry	1286	25%	1611
Additional System Margin			197
Spacecraft Total Dry	1286	41%	1808
Propellant	2554	0%	2554
Spacecraft Total Wet (e.g., Separated Wet Mass)	3840		4363
LV Adapter	82.16	30%	106.81
Additional System Margin for LV Adapter			16
Launch Mass Wet	3923		4485
Injected Mass Capability / MMRTG capability			4555
Remaining LV Capability			70
JPL Design Principles Margin			35.6%

(ref. 6/2/08)

Example JEO Power Profile: 2 Orbit Scenario with Targets



(Ref. 5/29/08)

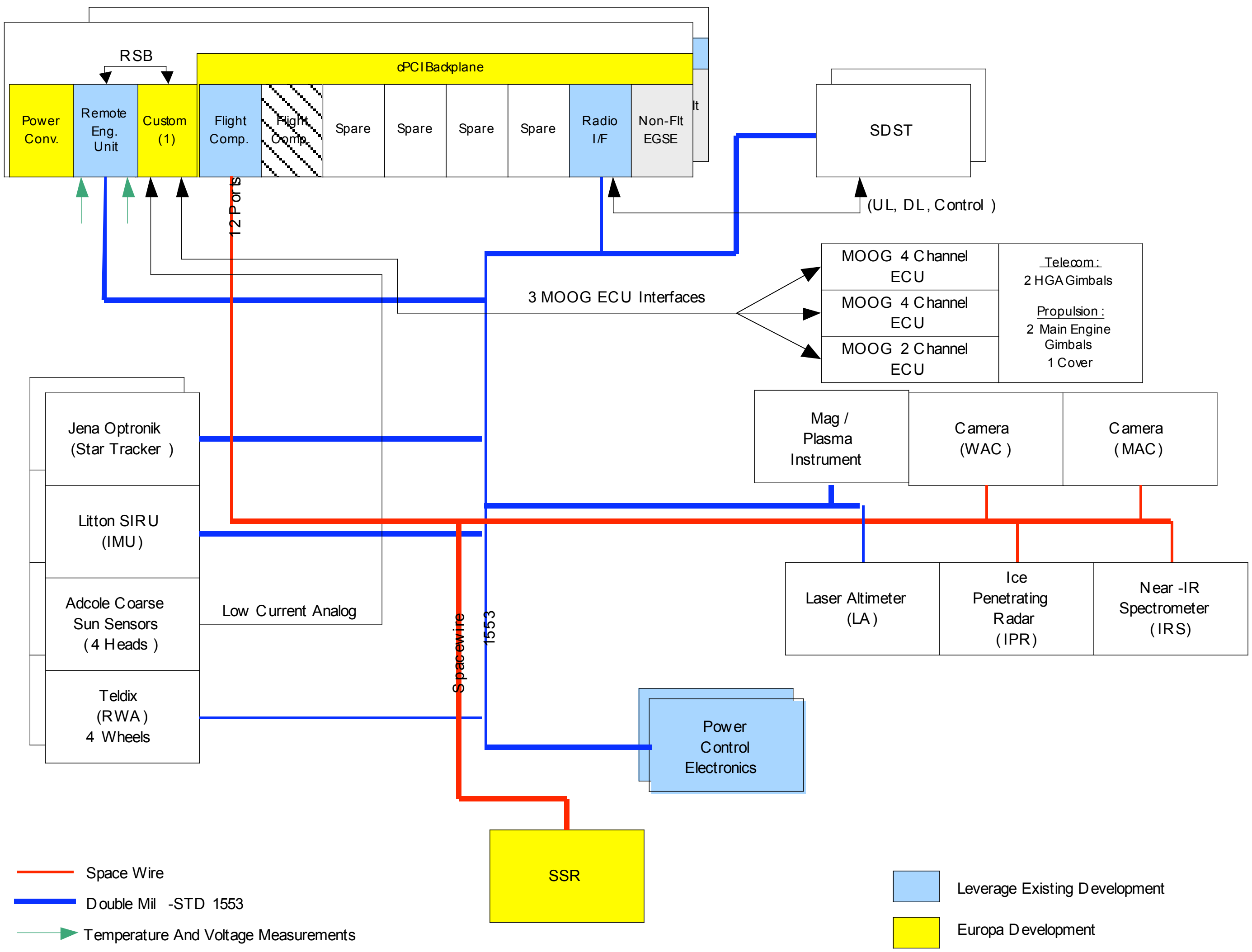
Key JEO Performance Parameters

Parameter	Baseline Value	Comments
Planning Payload		
Number of instruments	7	Includes Ka/X-band used for radio science. Assumed WAC+MAC as a combined instrument
Instrument mass	73 kg	Current Best Estimate. Does not include telecom H/W used for radio science or mass for instrument shielding.
Instrument power	101 W	Current Best Estimate
Science Accommodation		
Pointing accuracy	1 mrad (3 σ)	Per Baseline mission, likely to be relaxed further with analysis. S/C body pointing control accuracy during nadir-oriented non-thrusting orbital period.
Pointing stability	10 μrad/s (3 σ)	Per Baseline mission, likely to be relaxed further with analysis. For body-fixed instruments in science orbit during non-thrusting periods.
Minimum duration between reaction wheel orbit desaturations	24 hours	Minimum duration between desaturation thruster firings.
Science Data storage	1 Gbits	Radiation tolerant, non-volatile, phase changing CRAM in baseline design
Data volume	7 Gb/day	Assumes 3 dB link margin, multiple data rates optimized for range, elevation, Jupiter presence, 34 m stations receiving whenever in view and 90% weather.
Spacecraft		
Processor speed	132 MHz	RAD750 flight computer
Available power at EOM	531 W	Power output from 5 MMRTGs at EOM
ΔV requirement	2490 m/s	Assuming launch mass is equal to the launch vehicle capability
Radiation design point	2.6 Mrad	Radiation design level behind 100 mil of aluminum for flight system shielding. Most electronics will be designed to 300 krad with RDF =2. Based on FY07 environment, being updated.
Heliocentric operating range	0.7 to 5.2 AU	Minimum range defined by VEGA trajectory.

Key Instrument Interfaces

- Power Interface
  - Instruments to operate within 22 to 36 V DC voltages
  - Instrument power would be switched by the spacecraft
- Data Interface
  - Instruments would interface command and data interface using Mil-std 1553 for low data rates and Spacewire for high data rates
  - Time distribution, synchronization to spacecraft time, and science data time tagging can be accomplished to within 1 microsecond
- Computational Resources
  - Instruments would provide for its own computational needs. However, potential spacecraft computing functions, such as low level data compression, may be negotiated after selection
  - Spacecraft would provide a total of [TBD] bits of non-volatile memory for storing executable instrument commands, parameters or software
- Data Volume (Europa orbital science)
  - Downlink data rate average: ≥120 kbps
  - Daily downlink average: 7 Gbit/day
- Instrument operations
  - Level of interactivity with spacecraft
    - Constraints on other activities
    - Measurements simultaneous with other instruments

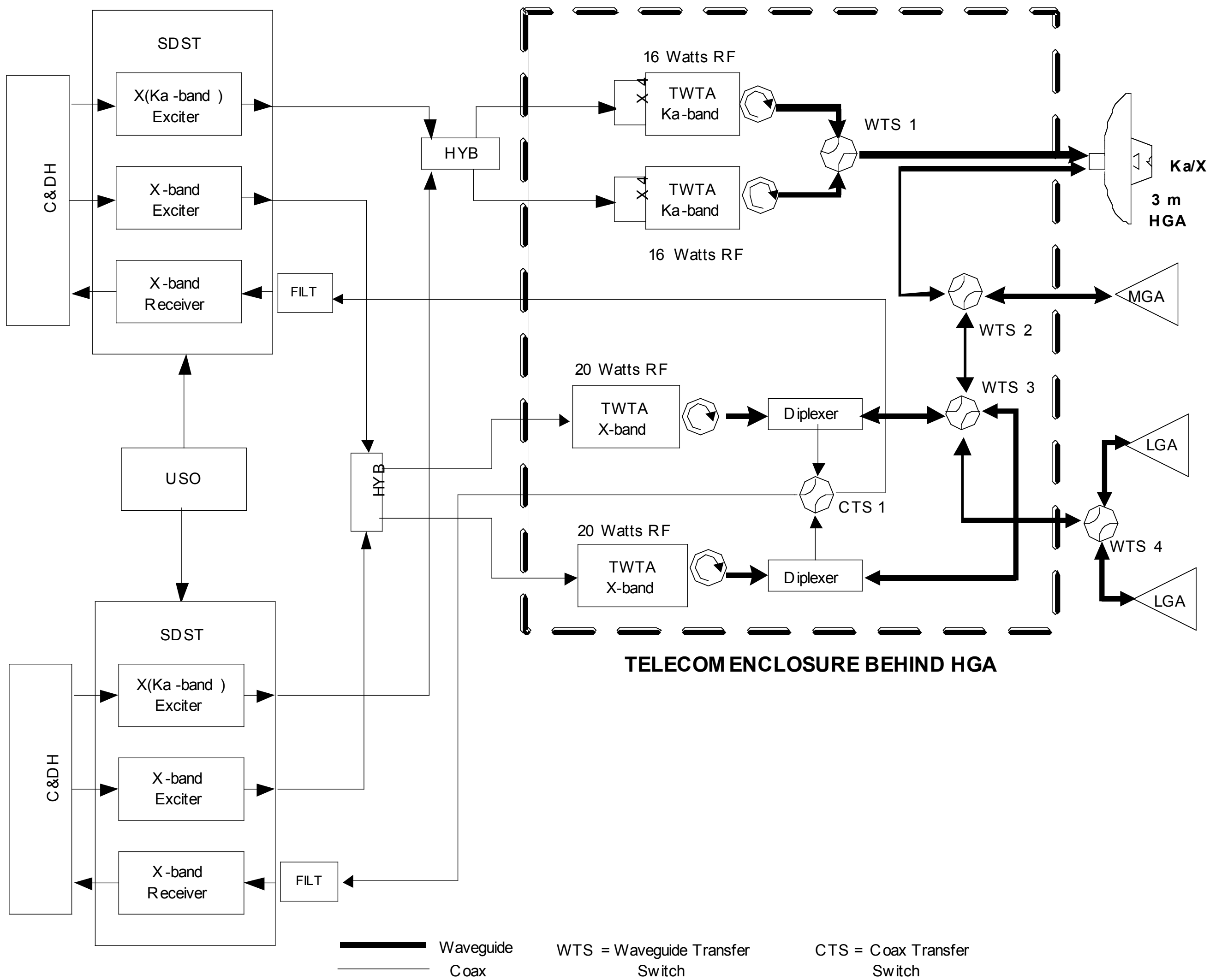
JEO Command & Data Handling System



JEO Data Storage

- Due to the lack of radiation tolerant memory parts:
  - Any Europa mission faces serious challenges in collecting and returning significant remote sensing data
  - Europa mission-developed data collection and return scenarios based on small mass memory size (~1 Gb for science)
  - Operational scenarios are highly constrained and do not allow:
    - Long term data storage (hours) for retransmission, on-board data processing, or long downlink tracking gaps
    - Collection of high rate data when not simultaneously downlinking and storing
- Mass memory provides:
  - Short term rate buffering for bursts of high rate data
  - Storage of low rate data collected during collections

JEO Telecom Design



Unique Instrument Technical Challenges

- Radiation tolerance
  - Sensors and supporting electronics located outside radiation-shielded chassis may need their own shielding (included in current mass allocations)
- Planetary protection
  - Expect to meet PP requirements by some combination of dry heat or radiation exposure sterilization
  - Some critical parts, such as detectors, that cannot tolerate either of these sterilization techniques may need to be fabricated in a sterile process
- Data rate reduction
  - High-rate instruments would be required to include large internal data reduction factors via compression, editing, summing, etc.

Future Trade Studies of Interest

- Increase size of SSR for Jupiter System science (possible hybrid SSR)
- Consider Op Nav camera needs for targeted flybys
- Fine-tune RWA sizing to accommodate selected instrument needs
- Relax pointing control based on selected instrument suite